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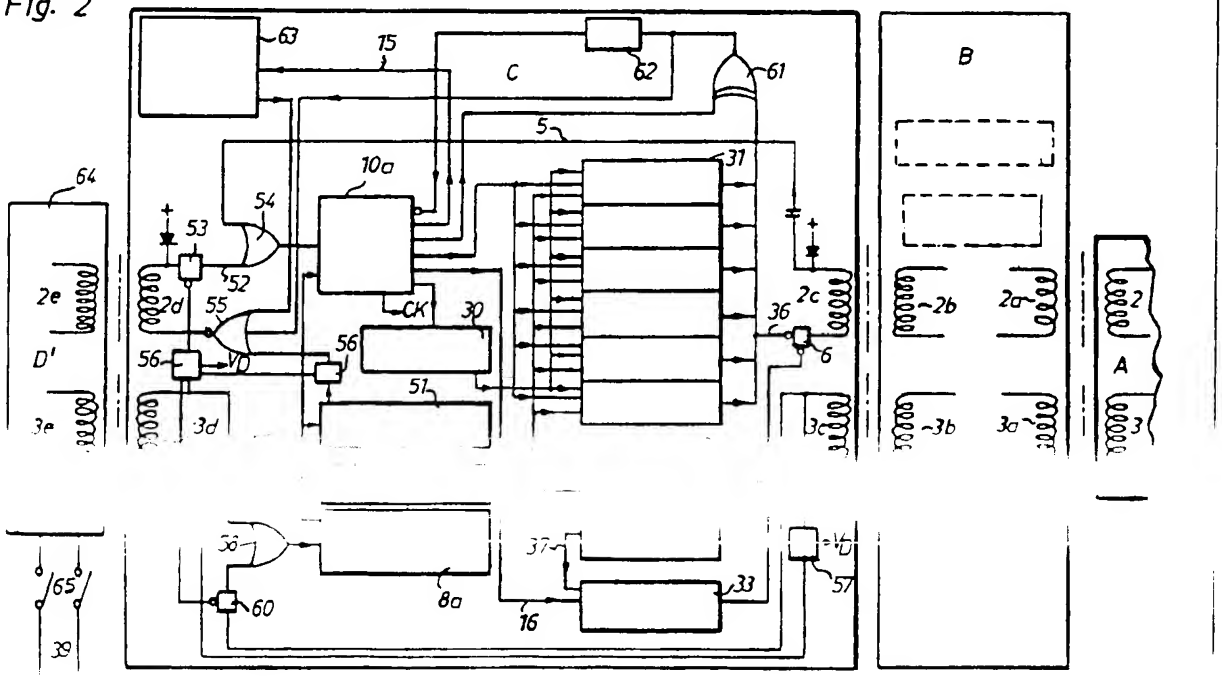
(54) Security in electronic fund transfer systems

(57) A technique for moneyless small cash transactions by means of an electronic purse device with contactless data transfer is described from the point of view of overall systems performance using changeable genuity test data, in accordance with British Patent Application 8028824. It is shown that a genuity test of the described kind must apply not only to the mutual testing of the purse or pay device and the point of sale terminal but also as between the latter and the bank computer to which sales point takings are to be electronically transferred.

Guide lines are given how attempted fraud can be met by using a sequential number incremented by one with every transaction and which is countercheck-ed by the Banks Computer. In combination with location codes uniquely attached to transaction terminals, attempted fraudulent action would be rapidly discovered.

The remote but feasible possibility of a person meddling with his account number to avoid being debited for purchases made, is met by a linkage established between said number and the variable test number in such a manner that any incongruity due to changed account numbers would be discovered at the sales terminal itself.

Fig. 2



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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy

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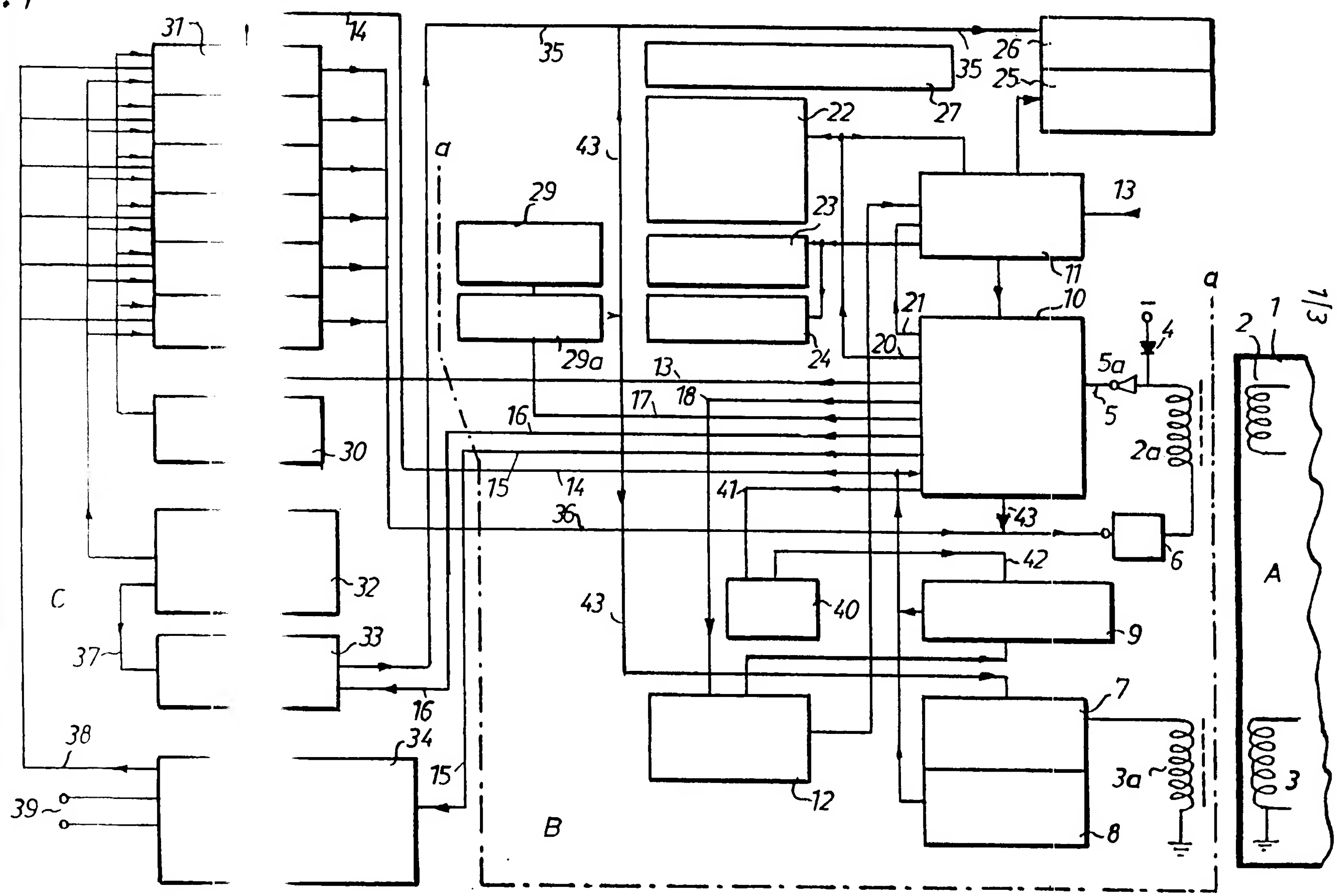
i. 1


A
B
C
a
a
1
2
3
2a
3a
4
5
5a
6
7
8
9
10
11
12
13
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14
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29a
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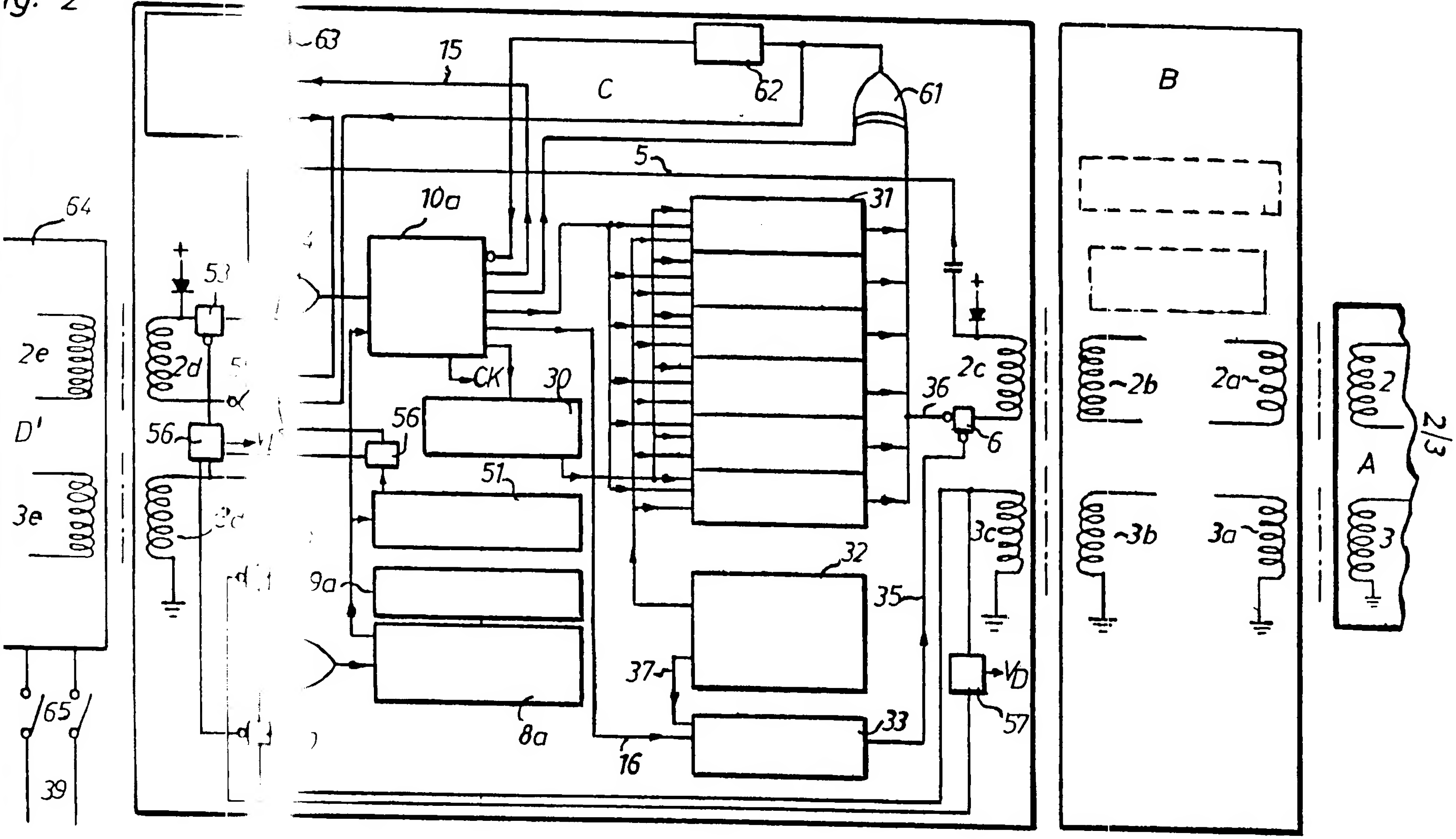
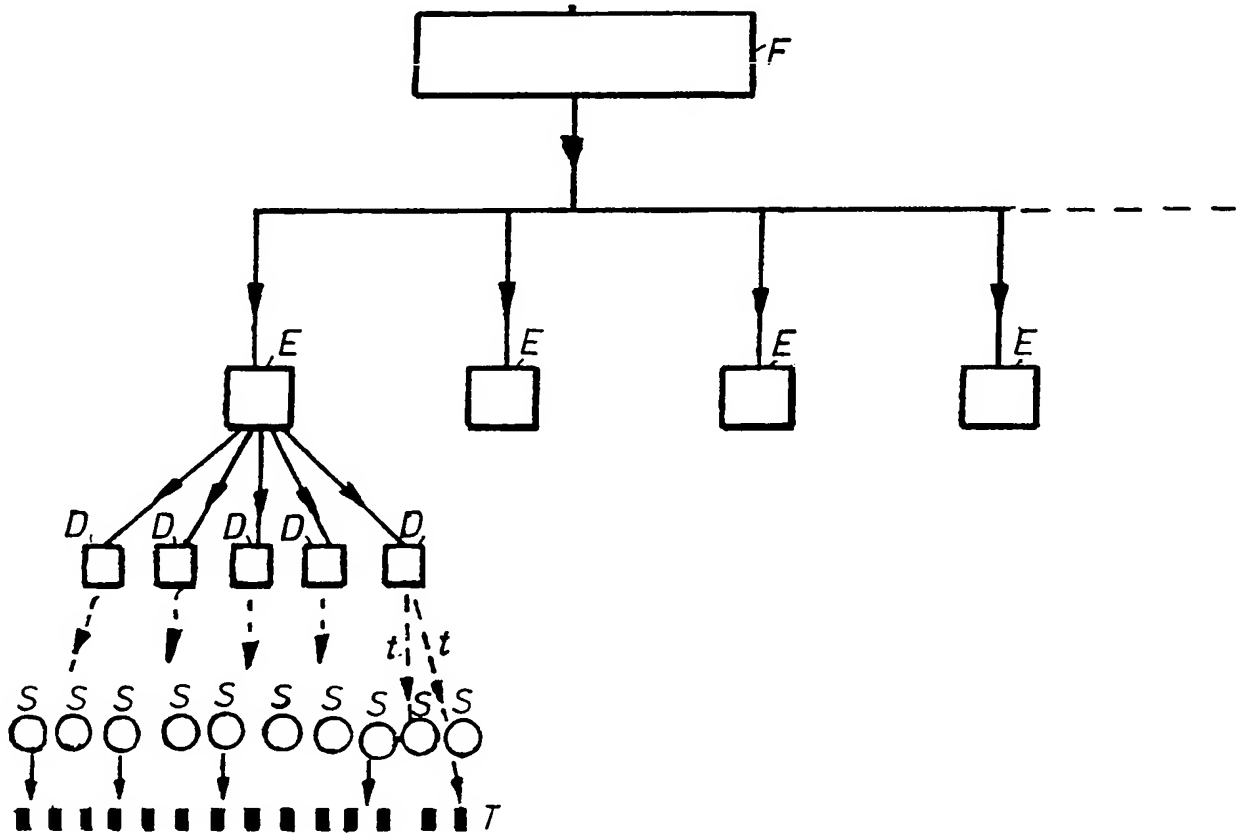
ig. 2



2/3
A
2
3
B
2a
2b
3a
3b
C
2c
3c
6
36
5
61
62
63
15
31
32
33
35
37
16
57
V_D
10a
CK
30
51
56
9a
8a
53
2d
D'
2e
3e
64
65
39

Fig. 3



SPECIFICATION

Hierarchic arrangement for the verification and renewal of security data in electronic fund transfer systems

Our patent application BP 8028824 entitled Security Arrangements in Data Transfer Equipment describes measures for ensuring that data contained in a data storage station cannot be read out without that station first passing a 'question and answer' test which is of such a kind that stereotype – that is forgable – test answers cannot be given by that storage station. A safeguard against the possibility of a set of test numbers becoming known, for example through unauthorized manipulation of the equipment, has further been described in the above cited application; it consists in arrangaments for changing the relationship between test number storage addresses and the test numbers as well as in procuring entirely new test numbers, at regular or irregular intervals of time. The description speaks of a cyclic change in the significance of the numbers which to begin with are 'active', then 'semi-retired', then vacated numbers. Vacated numbers are always replaced by new 'active' numbers. These test numbers, originating as they would from a single centralized Head Quarters of a bank or a central Clearing Bank and transmitted from there via scrambled dedicated data lines to the branches of banks, credit institutes, etc., mainly during night times, would be very safe from unauthorized inspection or interference especially if the security measures described hereunder are applied.

Already in our patent application ser mo 8028824 a method of changing test numbers without loosing region- or nationwise validity at transaction stations was described. The description was fairly complete as far as the data transfer between a portable data token and a transaction station is concerned; however, it failed to show the exact security measures that would ensure that only an authorized station would be able to change the test codes, and that the transfer of transaction data to another data station is dependent on the fulfillment of certain test conditions. An investigation of the overall requirement shows that the concept of a self-repairing security system that was applied in pat. appl. 8028824 for the data transfer between a widely distributed 'pay token' and point of sale or transaction terminals would also [illegible]

[illegible] test numbers from the said Clearing Center or Bank H Q from and to the branches. Thereby one arrives at a hierarchical arrangement for the passing on of periodically changing test data, in the context of an unpredictable sequence of right and wrong test numbers.

In order to take account of the requirements of an overall secure system it became necessary to develop the circuitry of Figure 2 of the cited patent application in greater detail resulting in a re-arrangement of circuit units as follows:

an associate data transaction controller unit, '*B*', a with 'B' associable self-contained component '*C*', and a computer station at a bank branch, '*D*', wherein all the named units contain reactive coupling links.

D can also be an intermediate signal converter from which the data contents can be received/transmitted to a data center D by a pair of telephone lines. The interrogation principles applied between D and C would be analogous to thise described for the interrogation of A by B, or respectively B by A.

For the better understanding of the improvements presented by this pesent application, the circuitry of Figure 2 of the cited application is here recapitulated in a block-diagrammatic form of the present Figure 1. Figure 2 of the present application shows the methamorphosis in sufficient detail. Figure 3 gives a survey of the total systems structure with respect to the data flow therein.

Detail Description of Figure 1

A represents the circuit of the portable data component as given in Detail in Figure 1 of the cited patent application. The inductive coupling arrangement using coils 2 and 3, and the electrical detail circuitry connected therewith is described in the applicants application nr. 7931208. Therefore, these details are not being repeated in this paper, although some elements are indicatively included in the diagrams.

The associable transaction control terminal has corresponding coupling coils 2a for the bidirectional transfer of data and 3a for passing on clock pulses and energy to component A. A clock phase counter and decoder 8 helps to differentiate between clock pulses having different roles and timing; in conjunction with a program counter 9 the data multiplex circuit 10 addresses and activates various portions of the circuit at the required times and sequences via internal (microelectronic) wires 19,14,15,16,17,18,20,21,41 and 43. For example the synchronizing pulses comes over wire 41 which ensure that the program counters in A synchronize with program counter 9. The address or reference number which originated in token A is passed to the address decode unit 30 via wire 19. The selected test number of unit 31, flanked by one or two 'wrong' test numbers, is clocked out via wire 36 and a current amplifier 6 into the transfer coils 2a-2 and circuit *A*. Similarly, debit data are transferred via wire 43 to the

[illegible] the response shows a faulty answer the circuit puts an inhibit signal on the Oscillator 7 via wire 43 and also produces a 'faulty' display via wire 35 on the display section 26. After the token has been tested satisfactorily the value of the token, or of the selected token account (see co-pending application entitled 'Portable Data Carrier out and shown up in store/display section 22. The debit calculator 11 responsive to a debit input 13 calculated the reduced token or account value and displays it in section 24. This display must be in agreement with the subse-

11 directly which is fully described in the cited patent application 8028824. The token is of course also tested against general qualifying data such as a code for the national network within which the electronic fund transfer token has validity or personal membership etc. This comparison is carried out by circuit blocks 29 and 29a, and if this test is defect the intended transaction is rejected.

The buffer store 34 was meant to contain the new test numbers offered for example via telephone connection to the terminal. However, this was by way of indication only; it was always clear that security against arbitrary insertion of test data would have to be high, as high as that provided for all data exchanges in the system. Moreover, since the data in memory store 31 constitute variable data it is necessary to ensure that the functionally associated circuitry cannot be bye-passed and this is best achieved by integrating all the related circuits on a single substrate. This includes at the very least the automatic sequencing changer, the response evaluator, the address decoder, and all the multiplexing circuit elements. The transaction memory 63 should be fully encapsulated conjointly with the integrated circuitry. This leads to a separation of Figure 1 into two sections, B and C, the boundary of 'B' being indicated by the line a - a. This re-arrangement reflects in the diagram Figure 2. Here, A and B are now represented by reactively coupled circuit blocks. Again reactively coupled to this system is now section C in which 321 is the block of registers for the wrong and right test numbers. (Note, even the wrong test numbers have address-enable inputs; these, however, are only used when new test numbers are inserted into block 31 to replace 'vacated' test numbers; on such occasions even the wrong numbers are changed at times, for good reasons.)

Most of the circuit blocks can be recognized as having been contained in Figure 1; the multiplex circuitry, the program counter, and the clock phase decoder had to be duplicated, (10a,9a and 8a).

For communicating with a data center such as a bank branch D there are built into block C two further coupling links 2d and 3d which are capable of being coupled with coils 2e and 3e in unit D. (In Figure 2, D' represents a MODEM whereby C can communicate with D via a pair of ordinary telephone lines).

The OR gate 54 can accept input data either from coupling coils 2c or 2d. Similarly OR gate 58 acceps clock pulses either from coil 3d or 3c. Simultaneous inputs are inhibited by switches 59, 60 and 53

[illegible] individually, such as Account Number of token owner, bank branch code, date and debit amount. In order to read out this record from storage unit 63, certain conditions must be fulfilled. the interrogating computer unit D will check on the qualifying data held in store 51 which also delivers an address number for the first test number held in store 31. Computer D must then generate the corresponding test number and transfer it to unit C where it is compared in exclusive OR gate 61. This is repeated for each of the [illegible]

62 latches and inhibits any further processing. This is a safeguard against the transaction memory loosing its data through an unwarranted readout. After the test and readout steps are caried out there remain further program steps in the program counter; these may be used for providing a mark to existing active numbers whereby they are transferred to the class of semi-retired numbers; and for vacating another test number from the last-mentioned group to replace it by an entirely new test number. Finally, also for changing one or the other of the so-called 'wrong' test numbers so as to eliminate all familiarity elements from the test number structure. As already indicated, the unit 'C' consists of one or more integrated circuit chips potted in a box which is fully sealed allround. A rechargable battery may be integral within the device.

As a rule, the unit 'C' would be removable from its location within the chassis of unit 'B', and may be bodily taken to the trader's own bank branch for the purpose of transferring the information contained in storage segment 63 to the computer of the bank branch concerned in order to debit the various accounts of the trader's customers and to credit the account of the trader concerned. That this provides the opportunity for also changing the said variable test numbers is an administrative matter which need not concern the trader.

The transaction list of memory 63 provides space to register for each transaction the account number of the token, the debit, a transaction sequential number, a serial number for the location of the terminal, and a date. The transaction number is obtained from the token A and represents the number of transaction carried out with the token up to the moment before the next transaction. As the token is checked into sales terminal B this number is incremented by 1 and returned to the token, also passed on to unit C to be added to the transaction information in store 63.

Figure 2 indicates two stores in the Sales Terminal B, the just referred to store receiving from A the current transaction number and increasing it by 1. The other store holds the permanent location number identifying the location of the terminal; also these data are passed on to the store 63 but need not necessarily be repeated here for each transaction although further downstream, when transaction data are transferred to the banks' computers, they have to be added together with the time information. All these data are needed for a certain amount of [illegible]

[illegible] retired test numbers first described in patent application 8028824 may also be used to protect the inalterability of the account number. This would be done by providing in the token for two account registers one of which holds the true account number whereas the other holds a function of the account number and the test number held in the token. A simple case is where this function is a difference. Call AN the account number, TN the test number. The said second account store must then hold a number 'an' = AN - TN irrespective of sign

When the token is checked into a point of sale terminal or into an updating terminal *both* account numbers are read out and their difference formed in an arithmetic circuit the terminal must be equal to TN. If it is not equal the comparator produces an output signal disabling all further operation and providing a visual indication such as 'defect account number' or 'token retained for check-up'.

Since, as has been described in the referenced documents, the test numbers change at irregular intervals, also the deduced AN numbers will necessarily change as well in the course of time. A potential forger of the account number will find himself rejected, assuming he may altogether succeed in incorporating a suitably multiplexed but nevertheless directly accessable micro-store for holding account numbers which he may at will vary. Because, according to the above defined scheme, it would not be enough for the would-be forger to generate an account number different from his own, he must also enter a new AN number which is related to the test number held in the token. This test number, however, is so locked into the circuitry that it has no outlet for being read from the circuit. Not knowing what this number is, the would-be forger could thus not effectively alter the account number of the token. The only other approach for him would be to try to monitor, if that were at all possible – and this depends partly on the detail techniques employed in the data transfer – the transfer means at some point. This would require elaborate apparatus difficult to place at a publicly accessable terminal. At other points these data would be completely inaccessable. Nor could any person be asked what the test numbers are at a given time since, they are electronically random-selected at the Head Quarter computer of the Clearing House. They are transmitted in scrambled form to Banks and Branches all over the country at unpredictable dates and times and occupy the system lines for only an infinitesimal portion of the operating times. The token terminals at Banks would not permit meddling with them and would incorporate precautions against information tapping and the opportunities for doing unusual things unobserved would be rare. Whereas one can never exclude one occasion when all the circumstances happen to further an unobserved fraudulent attempt at discovering the test number, the likelihood that this can be repeated, say week by week, is non-existent. The risk for being observed and apprehended would be the greater as bank computer

[illegible] repeat illegal intelligence, even if it is possible; yet, the system of variable test numbers would make it necessary to monitor them continually.

In summary, with the aid of the variable test numbers technique a forge attempt directed at the account number of the pay token, can instantly be refuted and the intended sale is stopped.

Figure 3 shows how new test numbers which originate at a National Bank Headquarters or a Clearing House Center 'E' are communicated to

ches 'D' of the various banks via dedicated scrambled data lines. The local bank branches, post offices (giro) and credit card agencies pass on any new test numbers to the cumulative transaction box 'C' when checked in physically at their respective terminals or, via phone lines t. When the box 'C' – as would normally be the case – forms part of the point of sale terminal S it passes on to the individual tokens T when presented to S the new test numbers concerned. While, in theory, it might be possible to tap the new test signal while it is being transmitted to a data token it is well within the scope of the art to place great obstacles into the path of a person wishing to do that at a public terminal with fraudulent intent.

Summary. a novel cashless value transfer system is described which permits the use of permanent electronic tokens while maintaining a high standard of security and versatility. The procurement cost of the equipment would be distributed over several agencies. The tokens, being permanent, would be issued to the public against registration and an annual membership fee from which the cost of supply and administration can readily be covered. The box C would be purchased by the individual trading firms. Banks would purchase terminals and hire them out to traders. Dedicated data lines for the transmission of inter-bank data already exist, or would shortly exist; they would be only lightly loaded by the proposed system.

CLAIMS:

1. An electronic fund transfer and data protection system comprising

(A) portable data carriers

(B) transaction terminals

(C) a self-contained portable storage unit for storing security test numbers and a list of transaction events data obtained from said transaction terminal

(D) a computer unit with data storage space for receiving transaction event data from units 'C' and for imparting new test numbers to said units 'C'

(F) one originating station where security test numbers are defined and electrically passed on to computer units 'D'via dedicated communication lines

2. An electronic fund transfer and data protection system wherein units A, B, C and D have each reactive coupling links

[illegible] incorporates a store for several test numbers, and that one of these is selected by means of a reference address which is transmitted by unit 'A' when associated with unit 'B' via B to unit 'C' whereupon the selected test number together with "wrong" test data is transmitted back to unit A via unit B.

4. An electronic fund and data protection system as in Claims 1 and 3 in which unit 'A' receives the combination of right and wrong tests signals and transmits to unit 'C' via unit 'B' its evaluation signals of said test signals whereupon unit 'C' examines said

an output voltage which inhibits further processing if the evaluation by unit 'A' proves to be defect.

5. An electronic fund and data transfer and protection system as in Claim 1 characterized in that the unit 'C' has two separate input/output reactive coupling links that portions of its circuitry can be accessed via either of these links, that is to say, either by transaction terminal 'B', or by Computer Terminal 'D' via auxiliary Modem D', but not by both units simultaneously.

6. An electronic fund transfer and data protection system as in Claim 5 wherein inhibit gates are provided to prevent simultaneous coupling of unit 'C'

7. An electronic fund transfer and data protection system as in Claim 1 wherein unit 'C' has a storage register for storing test number address data, and means for transmitting these data to a computer installation 'D', storage means in the computer D to store test numbers and addressing means to select one of these numbers for readout by an interrogating station, means in the unit 'C' for receiving and comparing such a selected test number with that stored in its said storage register, and means to stop the communication link with the computer if said comparison is defect.

8. An electronic fund transfer and data protection system as in Claim 7 wherein the data transfer program in unit 'C' permits the readout and subsequent testing of all the test numbers held in its memory against corresponding test numbers held by the computer unit and produced in response to consecutively transmitted addresses sent out by unit 'C', and means in the unit 'C' circuitry to stop the communication link with the computer if any one of the comparison tests fails.

9. An electronic fund transfer and data protection system as in Claim 1 characterized by means in the computer D for receiving intructions via dedicated data communication networks for earmarking currently 'active' test numbers as 'semi-retired' test numbers, and of ear-marking currently 'semi-retired' test numbers as replaceable by new test numbers, furthermore means in the computer D for receiving and storing new test numbers, means for encoding a semi-retired number and for transmitting said code or flag to unit 'C' within the time-multiplex plan of its program cycle, and means for displacing a retired number in unit 'C' storge space and for replacing it by said new test number.

10. An electronic fund transfer and data protection system as in Claim 9 the computer unit D being

[illegible] inhibit means in the circuit of unit 'C' preventing said readout if the computer response to the test number addresses sent out by unit 'C' proved to have been defect.

11. An electronic fund transfer and data protection system as in Claim 10, in which said transaction list store contained in unit 'C' consists of a tape deck with stepping motor and that said motor is powered by inductive coupling to data controlled stepping pulses, and which stepping pulses pass through an inhibit gate controlled by a logic signal in the circuit of unit 'C'

12. An electronic fund transfer and data protection system as in claims 1 to 11, wherein the major part of the circuits of unit 'C' constitute large-scale integrated circuits incorporated in an externally smooth and contactless, readily transportable tablet.

13. An electronic fund transfer and data protection system as in claims 1 - 12 wherein the portable data carrier 'A' contains a store for holding a sequential number which is transferred to the circuit of the transaction terminal 'B' where it is incremented by a number x and returned to the data token at a predetermined time slot of the transaction cycle.

14. An electronic data transfer system as in claim 13, wherein provisions are made in the self-contained portable storage unit 'C' for storing the said transaction number as an adjunct to the particulars of each transaction within the transaction list memory in order to pass it on to the bank computers.

15. An electronic data transfer and data protection system as in claims 13 and 14, wherein the bank computers are programmed to compare the transaction numbers of consecutive transactions of the same account number and to reject any particular transaction if the discrepancy exceeds a preset amount and to initiate a printout of the transaction details for further action by staff as required.

16. An electronic data transfer and fund protection system wherein the terminal 'B', of the portable storage unit 'C' contains a location code by which its installed location is recognizable, and means in the Banks' computers to attach this code to the transaction details for each individual fund transfer.

17. An electronic fund transfer and data protection system in accordance with the principles of variable test numbers described in British Patent Application 8028824 in which the portable data carrier contains two further registers to hold in on register a true account number and in the other register a derived account number, the latter being a function of said true account number and active test number held in the test number register of the said data carrier, and means for reading out from said data carrier both the true and the derived account numbers and the address code for addressing the corresponding test number register in the transaction terminal.

18.An electronic fund transfer and data protection system in accordance with Claim 1 - 16, and 17, the improvement consisting of the provision of processing means in the transaction terminal 'B' or the

[illegible] portable data carrier, generate a function of the interaction of the true account number and the duly addressed testnumber, comparator means to compare the number resulting from said interaction with the derived account number received from the portable data carrier, and if identity is not establish by said comparator, the transaction is disabled and displayed as rejected.

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